APPENDIX B

Engineering

Concept Design

Note: The concentrate grade and feed rate were altered part way through the study, as requested by Compass Resources. Ausmelt re-designed the smelter to treat dry injected, concentrates produced during years 1 and 2 of operation.

As substantial work had been completed, process data sheets and the process flow diagram were not re-issued by Ausmelt. Consequently, the information presented in the data sheets and process flow diagram do not directly correspond to the final process design presented in Appendix A.

The information presented in this chapter is based on the process design outlined in Appendix A to treat concentrates of the grade, moisture content and feed rate detailed in table A.1.1.

APPENDIX B CONTENTS

B.1 DOCUMENTATION

The following drawings describing the plant are included in appendix E:

?? Smelter Building General Arrangement AUS933-15-003

B.2 GENERAL PLANT DESCRIPTION

The proposed furnace system uses a single Ausmelt furnace to process Browns concentrates. Product matte and slag are removed continuously from the Ausmelt furnace to a settler via an underflow weir.

Offgas from the Ausmelt furnace is cooled and filtered through a dedicated offgas handling system. The collected fume containing ~ 70% lead is processed in a second Ausmelt furnace to produce bullion. Please note the requirements of the lead Ausmelt furnace are not addressed within this study.

A general operating description for the furnace system is contained in the Project Overview, section 2.

B.3 THE AUSMELT FURNACE

The Ausmelt furnace consists of an upright cylindrical steel shell with a sloped roof. The furnace is partly lined with basic refractories and copper cooling panels.

The furnace roof, transition piece and the upper part of the cylinder are cooled by a film of water flowing over the outside surface of the steel shell. Cooling water is collected in annular troughs and discharged by gravity to a dedicated cooling system for heat rejection and recirculation.

The lower 4 metre section of the furnace cylinder consists of a water-cooled copper panel system. The 'hot surfaces' of the panels are lined with a basic refractory. Cooling water is discharged directly to a dedicated cooling system for heat rejection and recirculation.

Please note, in considering furnace heat losses, Ausmelt assumed within the process design an average heat flux of 80 kW per m^2 for the cooling panels. For the purpose of this study, estimation of the cost of design and supply of the panels is the responsibility of Hatch.

The furnace sits on a steel grillage, which is supported by a heavy concrete foundation.

B.3.1 Furnace Dimensions

The furnace internal diameter is 4.4 metres. The external height from the base to the start of the roof section or top of the cylinder of the furnace is approximately 8.8 metres.

The working bath depth for the furnace is 1.1 metres.

B.3.2 Weir and Taphole

An underflow weir is used to continually transfer matte and slag from the Ausmelt furnace to the settler. The weir is refractory lined and designed to transfer matte and slag at the operating temperature. To help maintain the matte and slag at operating temperature the weir is fitted with a simple natural gas fired burner.

The furnace is fitted with a water-cooled copper tapping block to enable complete or emergency drainage of the furnace. The water-cooled block houses a single taphole at the hearth level.

B.3.3 Refractories

B.3.3.1 Furnace

The main furnace cylinder is divided into two sections.

The lower 4 metre section of the cylinder consists of cooling panels. The front face of the cooling panels is set back from the refractory hot face. A layer of basic refractory is placed in front of each cooling panel to act as the hot face material.

The top section of the furnace cylinder is lined with basic refractory bricks. A high conductivity graphitic mix is rammed between the bricks and the steel shell to increase heat conduction to the shower cooled furnace shell. The approximate temperature of the outside surface of the steel shell is 60°C.

B.3.3.2 Furnace Roof and Transition

The furnace roof and transition are lined with a layer of castable refractory. The outside surfaces of the roof and transition shell are water-cooled. The approximate temperature of the outside surface of the steel shell is 60°C.

B.4 AUSMELT LANCES

The Ausmelt lance delivers milled coal, air and oxygen into the slag bath for submerged combustion. The lance is also designed to inject the dry Browns concentrates directly into the slag bath. The flow rates of air, oxygen and fuel are regulated by the control system to achieve optimum, safe process conditions during operation.

Fuel, air, oxygen and concentrates are delivered to the lance via flexible hoses. The lance is fixed to a jib trolley, which is in turn raised and lowered by a wire-rope hoist to position the lance in the furnace.

Only one lance is in operation at any given time, with three lances on standby or undergoing tip repair. While not in use, the lances are stored in a lance park located adjacent to the furnace.

Worn lance tips are repaired in the lance park or in a suitable lance maintenance area. The lances are repaired by replacing a short length of the outer pipe at the tip. This is a simple and routine operation, typically performed by two people.

B.5 AUSMELT LANCE HANDLING SYSTEM

The lance handling system has two specific functions. These functions are described below:

B.5.1 Lance Positioning in the Furnace

The lance handling system is designed to allow the position of the lance to be set anywhere between the fully inserted and fully withdrawn position. The lance is located centrally over the furnace lance port and guided vertically by the lance jib trolley.

The vertical position of the lance jib trolley is controlled by a wire-rope hoist connected to the lance jib. The lance is fixed to the lance jib trolley via a flexible connection system that allows some freedom of movement during operation of the lance relative to the trolley.

B.5.2 Lance Change Over

Periodically, maintenance is required on the lances. To change the operating lance, the lance is raised to the fully withdrawn position and the lance jib trolley is locked in its parked position. When all the flexible hoses have been decoupled and the lance disconnected from the jib trolley, it is removed to the lance park by the overhead travelling crane and a replacement lance is installed. After reconnecting all flexible hoses and securing the lance to the jib trolley, the lance is ready for operation.

B.6 STANDBY BURNER

The Ausmelt furnace is fitted with a standby burner capable of heating the furnace from ambient temperature to the operating temperature of 1300°C.

To minimise thermal cycling the burner is used to provide the heat input to the furnace when the furnace is in standby mode, ie. lance not in operation. The purpose of the burner is to maintain both the bath and furnace refractories at the operating temperature.

The burner is also used to dry and pre-heat newly installed refractory linings. The high levels of excess air used for combustion ensure that the burner is capable of heating the furnace from ambient temperature to the operating temperature.

Please note that the burner is external to the furnace during normal operation to protect it from excessive radiant heat.

B.7 FURNACE COOLING SYSTEM

External cooling water is distributed over the top section of the furnace shell by troughs and spray manifolds. A film of water flows over the outside surface of the upper furnace's steel shell under gravity, before collecting in the return hot water tank for circulation to the water cooling circuit.

Water is circulated through the copper cooling panels through internal cooling passages. The water connections from the internal cooling passages will protrude from the outer shell to prevent water leakage within the furnace.

The total cooling water requirement for the furnace, including the tapping block is around 590 m^3 per hour. The copper cooling panels require 380 m^3 per hour of water. The top section, which includes the upper part of the cylinder and the roof, requires approximately 207 m^3 per hour of cooling water. The cooling water system is designed on a thermal differential of 10°C between inlet and outlet water.

B.8 AIR SUPPLY

B.8.1 Lance Air Supply

The lance air compressor system will be capable of delivering 12,240 Nm^3/hr of air at 150 kPa(g) during **normal** operation.

The lance airflow rate will be regulated by capacity control of the compressor system. This will help facilitate minimisation of power consumption.

The compressor system will deliver oil-free air.

Note an additional 20% above the normal operating rate is required when sizing equipment for the lance air supply system.

B.8.2 Afterburn Air Supply

The afterburn air compressor system will be capable of delivering 31,530 Nm^3/hr of air at 80 kPa(g) during **normal** operation.

The afterburn airflow rate will be regulated by controlling the capacity of the compressor system. Again, this will help facilitate minimisation of power consumption.

The compressor system will deliver oil-free air.

Note an additional 20% above the normal operating rate is required when sizing equipment for the afterburn air supply system.

B.8.3 Standby Burner Combustion Air Supply

The standby burner air compressor system will be capable of delivering 11,660 Nm^3/hr of air at 80 kPa(g) during **normal** operation.

The afterburn and standby burner air will be supplied from a common source.

B.9 FUEL COAL SYSTEM

Milled fuel coal is required for the process heat requirements during operations. The fuel coal system will deliver approximately 3,500 kilograms per hour of milled coal (**normal** operation), at the composition specified in Appendix E, data sheet AUS933 – 15013.

The fuel coal delivery rate will be controlled from the plant control system.

Note an additional 20% above the normal operating rate is required when sizing equipment for the coal delivery system.

B.10 NATURAL GAS SYSTEM

Natural gas is required as the fuel for the standby burner. The natural gas fuel system will deliver approximately 1,100 Nm^3 per hour of natural gas.

The standby burner natural gas fuel rates will be controlled from the plant control system via mass flow control trains.

Note an additional 20% above the normal operating rate is required when sizing equipment for the natural gas supply system.

B.11 OXYGEN SYSTEM

The oxygen compressor system will be capable of delivering 4,220 Nm^3/hr of oxygen at 150 kPa(g).

Oxygen is required for enrichment of the lance air during operation, as well as for tapping of the furnace.

For the purposes of this study, it is assumed that the purity of the oxygen provided to the plant is 95%.

Note an additional 20% above the normal operating rate is required when sizing equipment for the oxygen supply system.

B.12 FEED HANDLING SYSTEM

The feed handling system carries out the following functions:

?? Storage of the feed stream components prior to feeding to the furnaces

?? Control of the feed rates for each component of the total feed stream

?? Loading of the feed storage bins

?? Transfer of the feed material from the weigh feeders to the furnace

?? Agglomeration of the feed material

Accurate mass feed rate control is critical to the successful operation of the plant. The set points for the weigh feeders will be controlled from the plant control system.

Dry concentrates are pneumatically conveyed to the Ausmelt lance. The concentrates are injected into the bath through a dedicated annulus at a solids loading of 20 (kg of solids to kg of carrier gas).

The furnace flux materials must be agglomerated/amalgamated prior to delivery to the furnace in order to minimise carry over into the offtake by entrainment in the offgas stream.

B.13 INSTRUMENTATION AND CONTROL

A plant control system will carry out all control and monitoring functions in the plant.

All process controls and safety interlocks will be implemented via this plant control system.

Ausmelt's standard is 4-20 mA current loops for analogue measurement and control, and 24 VDC for digital signals. This can be modified to suit site standards. Air operated valves will be used for flow control, and variable speed drives will be used for motor control where required.

The control system monitors the instruments and performs all the control and alarming functions for the plant. Operator interface is via operator consoles located in the furnace control room.

The control system will include the following features:

- Display of process variables and status of motors and valves on screen based graphics
- Alarm logging, display and printouts
- Trending of process variables
- Storage of historical data with automatically initiated generation of production and maintenance logs
- Password protected access for system configuration and tuning

The control system will be powered from an Uninterruptible Power Supply (UPS) to cater for short term power failures and will include a line conditioner. The UPS will be capable of maintaining power supply for 20 minutes in the event of a power supply failure to allow the furnace to be safely shut down, or to allow the backup generators to be brought online.

The largest electrical loads for the Ausmelt furnace (study battery limits) are drawn by the control system UPS and the lance hoist. The UPS and lance hoist will be rated at approximately 10 kW and 40 kW respectively. These are the rated supply requirements. The annual Ausmelt furnace power consumption is well below these figures.

B.14 AUSMELT FURNACE BUILDING

The furnace building (accommodating the Ausmelt furnace only) will occupy a foot print area of approximately 20 metres by 20 metres and will rise to a height of approximately 50 metres. The height of the building is largely determined by the furnace elevation (11m elevation from the furnace grillage to the ground) and the clearance above the furnace (23m), both required by the boiler offtake.

The building will be constructed of steel with braced structural steel roof, frames and columns. The roofing material will be steel sheet, the design allowing for natural ventilation. The external walls will be clad with steel sheet.

One 30 tonne overhead travelling crane will be used for maintenance of the furnace. The building layout will provide an open letdown bay for the crane extending from the top of the building to ground level. The overhead crane will also be used to transfer lances between the lance jib trolley and the lance park during lance changing operations.

B.15 MATERIALS OF CONSTRUCTION – PIPING AND VALVES

The following description of the materials of construction refers specifically to the piping and valve systems defined within Ausmelt's scope.

B.15.1 Fuel Coal System

Carbon steel piping and fitting materials shall be in accordance with ANSI B336.10. Particular attention should be paid to bend radii. As a design rule, the ratio of bed radius to pipe diameter shall not be less than 10. Should spatial requirements require bends with radius less 10, then special bends such as high impact weir, 'Botswana' or 'Lobster back' bends may be required. Connections and fittings would be the same as compressed air.

B.15.2 Natural Gas

Natural gas pipe and fitting materials shall be in accordance with the Australian Gas Association's gas installation code. Acceptable materials for an operating pressure limit of 200 kPa are steel pipe to AS 1074 (medium grade), API-5L grade B, ASTM-A53 grade B or ASTM-A106 grade A or B. Welded flange connections are recommended. Screwed connections are acceptable up to a nominal pipe size of 50 mm.

B.15.3 Oxygen

Oxygen pipe and fitting materials shall be in accordance with Compressed Gas Association, Inc. publication, *Industrial Practices for Gaseous Oxygen Transmission and Distribution Piping Systems.* Acceptable materials for piping include grade 316L stainless steel to ANSI B36.19. All oxygen lines must be appropriately clean of foreign material and degreased prior to service. All in-line devices for oxygen service must be supplied degreased.

B.15.4 Compressed Air

For compressed air systems carbon steel pipe to ANSI B36.10 is adequate. Butt weld fittings shall be in accordance with ANSI B16.9 and B16.28. Flanges shall be in accordance with ANSI B16.5.

B.16 AUSMELT MAJOR EQUIPMENT LIST

The major equipment for the Ausmelt furnace system included in Ausmelt's scope of work for the design and costing study is shown in table B16.1.

Table B16.1 Ausmelt Core Technology Major Equipment List

Description	Quantity	Capacity	Installed Power
Ausmelt Furnace			
Furnace shell & Roof	1		
Furnace grillage	1		
Refractories	1 lot		
Water-cooled tapping block	1		
Copper panel cooling system	1 lot	Panels to be costed in study by Hatch	
Ausmelt Lances			
Ausmelt lance	4		
Lance hoist	1	25 MT	40 kW
Lance jib & trolley system	1		
Lance port sealing system	1		
Standby Burner			
Standby burner	1	42.3 GJ/hr Gross Heat Output	
Burner hoist	1	2t S.W.L	
Services			
Ausmelt flow control instrumentation & valves	1 lot		
Lance positioning instrumentation	1 lot		
Sample lance & jib	1 lot		
Furnace DCS control system	1 lot		10 kW